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Study on antennal sensilla and host preference analysis of *Nilaparvata lugens* (Stal)

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Abstract
The present study was conducted to document the sensilla present on the antennae of *Nilaparvata lugens* in the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore during the period 2012-13. The results showed that the antennae of *N. lugens* were comprised of three distinct parts *viz.,* scape, pedicel and flagellum. Plaque organs and trichoid sensilla were confined to the pedicel. The number of plaque organs on the pedicel increased with nymphal development. There were no difference in number and structure of sense organs of various forms and sexes. Two morphological types of hairs such as mechanoreceptive hairs and chemoreceptive hairs were distributed all over the pedicel of adults. The host preference study with *N. lugens* revealed that both nymph and brachypterous forms showed more preference for TN1 than Ptb33, while the macropterous form showed more preference for Ptb33.

Keywords: SEM, *Nilaparvata lugens*, olfactometer, sensilla, antennae

1. Introduction
The antennae of adult insects have various types of sensilla with different functions which play a crucial role in host-finding and mating [1, 2]. They exhibited a variety of forms and characteristics in relation to their functions *viz.,* contact chemoreception, mechanoreception and thermo-hygroreception [3]. Antennal sensilla are important sensory receptors [4] which were proved to be involved in the perception of different kinds of stimuli in different insect orders [5, 6, 7]. As most olfactory sensilla are located on the antennae of insects [8, 9], a detailed study of the antennal sensilla is necessary for better understanding of the host location mechanisms.
With regards to Fulgoromorpha, most studies on antennal sensilla have focused on putative olfactory sensilla, located on the pedicel [10, 11]. Indeed, planthopper flagellum sensilla are less in number than in many other insect, and it is of interest that typical chemoreceptors seems to be absent. This absence is probably compensated by the olfactory sensilla of the pedicel. In this respect, the low number of sensilla on the flagellum was regarded as a possible functional specialization of the flagellum itself [12]. Much research has been carried out on the systematics, ecology and pest status of this insect but little is known about its sensory physiology. The present study was conducted to document the sensilla present on the antennae of *Nilaparvata lugens.*

2. Materials and Methods
The Brown Plant Hopper (BPH) was mass reared on the susceptible rice variety, TN1 by following standard methods [13] in the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore during the period 2012-13. Initial BPH population was obtained from rice fields at Paddy Breeding Station, Coimbatore. The gravid females were confined on 35-days-old potted rice plants kept in cages (45 x 45 x 60 cm) for oviposition. After three days of oviposition, the spent adults were removed and the plants with eggs were placed in separate cages for the nymphs to emerge. The emerged nymphs were then transferred to 15 day-old TN1 seedlings raised in the germination trays. Then the trays were placed in galvanized iron trays (62 x 47 x 15 cm) containing 5 cm depth of water to maintain humidity and to avoid watering daily. The seedling trays were changed as and when necessary. Using this technique, a continuous culture of BPH was maintained during the entire period of study (Plate 1). Freshly emerged brachypterous and macropterous forms of BPH and the nymphs were used for the dissection of antennae.

Plate 1: Mass culturing of *N. lugens*

2.1 Documentation of Antennal sensilla of *N. lugens*

The antennal samples were prepared by following the procedure described [14]. Twelve individuals of brachypterous and macropterous forms of *N. lugens* and its nymphs were used for the documentation of the chemosensory structures and the dimensions of sensilla were measured with Scanning Electron Microscope (SEM) of model FEI QUANTA 250 (Netherland), Department of Nanotechnology, Tamil Nadu Agricultural University, Coimbatore. Abundance and distribution of the antennal sensilla types were documented for nymphs, brachypterous and macropterous forms of *N. lugens.*

2.2 Y-tube experiment

The Y-tube olfactometer with dual choices was used to measure the behaviour of *N. lugens* (Plate 2). Devices were placed on a table at a vertical distance to avoid contamination or influence of other hosts. Bioassays were conducted at 24±1 °C and 55-65 per cent relative humidity. Two different hosts *viz.,* TN1 and Ptb33 were used. The insects were starved 3-4 h prior to each assay. Ten insects each from nymph, brachypterous and macropterous forms of *N. lugens* were released separately and air was drawn from hosts and blown to the arms. The instrument was cleaned with acetone and hexane before each trial of experiment. The number of insects reaching different arms was counted after 10 minutes for further analysis [15]. The experiment was repeated for about 12 times and fresh insects were used for each time.

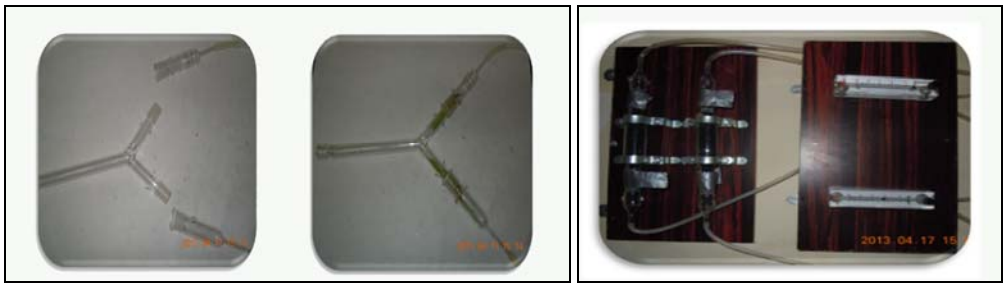

Plate 2: Host preference analysis for *N. lugens* using Y-tube

3. Results

3.1 SEM images and dimension of *N. lugens* antennae

The antennae of *N. lugens* comprised of three distinct parts, basal scape, a bulbous pedicel and an unsegmented flagellum (Plate 3). Plaque organs (Plate 4) and trichoid sensilla were confined to the pedicel. There was no difference in the structure of sense organs with regard to various forms of *N. lugens*. Each plaque organs consisted of a cluster of hair-like projections surrounded by outer protective non-sensory denticles. The plaque organs were about 20.23±2.8 to 40.72±2.0 µm in diameter (Table 1) and were separated from each other. Two types of morphologically different hairs such as mechanoreceptive and chemoreceptive hairs were observed on pedicel (Plate 5). One type was set into a depression in its base and the other in a raised socket. They were distributed all over the pedicel of adults and the length of mechanoreceptive and chemoreceptive hairs ranged from 12.33±1.3 to 35.98±1.7 µm and 13.27±1.3 to 37.14±1.6 µm, respectively. The length of mechano sensory hairs and chemosensory hairs and diameter of plague organ were showed their significance as follows macropterous, brachypterous and nymph.

Table 1: SEM dimensions of antenna and plague organ of *N. lugens*

S. No.	Forms	Length (µm)*		Plague organ (dia. µm)*
		Mechano sensory hairs	Chemo sensory hairs	
1.	Nymph	12.33±1.3c	13.27±1.3c	20.23±2.8c
2.	Brachypterous adult	25.65±1.4b	28.85±1.3b	31.59±2.2b
3.	Macropterous adult	35.98±1.7a	37.14±1.6a	40.72 ±2.0a

* Mean of 12 replications

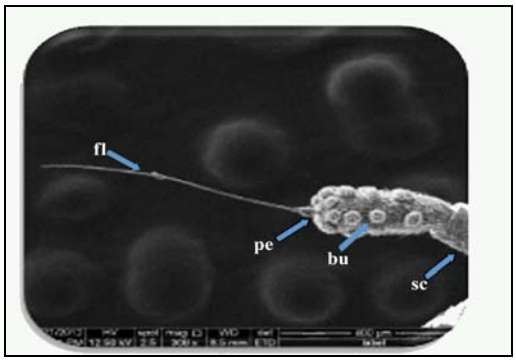

Plate 3: Structure of antennae in *N. lugens* (fl-flagellum, pe-pedicel, bu-bulb, sc-scape)

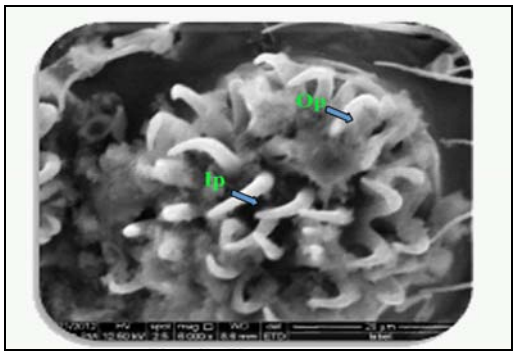

Plate 4: Plague organ (IP-Inner Projection; OP-Outer Projection)

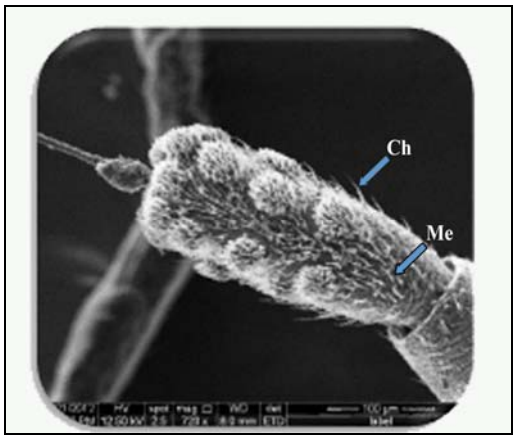

Plate 5: Sensory hairs (Ch-Chemoreceptors; Me-Mechanoreceptors)

3.2 Y-tube experiment

The experiments were conducted to find out the host preference of *N. lugens* using Y-tube. The experiment was repeated for about fifteen times to find preference behaviour towards the host. Nymphs and brachypterous forms of *N. lugens* showed more preference for TN1 (7.13 and 7.67, respectively) than Ptb33, while, the macropterous form showed comparatively less preference for TN1 than other forms (5.47) (Table 2).

Table 2: Host preference of *N. lugens* under Y-tube olfactometer

S. No.	Host	Nymph (nos.)	Brachypterous (nos.)	Macropterous (nos.)
1.	TN1	7.13 (2.66) $_a$	7.67 (2.76) $_a$	5.47 (2.32) $_a$
2.	Ptb33	2.87 (1.66) $_b$	2.33 (1.48) $_b$	4.53 (2.11) $_b$
SE(d)		0.098	0.126	0.105
CD (0.05)		0.201	0.258	0.215

* Mean of 15 replications

4. Discussion

4.1 SEM images and dimension of *N. lugens* antennae

The antennal morphology of *N. lugens* revealed that the antennae contained three segments of a short antennal scape, a cylindrical antennal pedicel and a thread-like antennal flagellum. Similar kinds of antennal sensilla with most fulgoromorphan species was reported [11]. This findings support the present observations on antennal morphology. As the nymph develops, the number of plaque organs on the pedicel increased, whereas, no difference in number and structure of the sense organs of various forms and sexes were observed.

The antennae of *N. lugens* were characteristic of the Fulgoroidea, consisting of an enlarged pedicel bearing most of the sensilla and an undifferentiated flagellum with a swollen sensory region near its junction with the pedicel [16]. Scientists [17] studied seven species of fulgoroid bugs with the scanning electron microscope and found the morphology of plaque organs could be correlated with other classification of this group [18]. However, the plaque organs of *N. lugens* did not fit into Marshall and Lewis's own classification, being more similar in shape to the plaque organs of Tropiduchidae than of Delphacidae, although the total number of plaque organs per pedicel was close to that found by Marshall and Lewis in Delphacidae.

4.2 Y-tube experiment

The experiments with Y-tube olfactometer revealed that the nymphs and brachypterous forms of *N. lugens* preferred TN1 whereas macropterous preferred Ptb33. The insects may have the ability to discriminate between host and non-hosts and between hosts of different quality [19-22].

5. Conclusion

Thus the documented sensilla have receptors which play an important role in host plant selection for their life. The different forms of the planthopper are all have similar behavior in selecting their host. Hence, the further study on physiology of the receptors will be more useful to reduce the pest in the ecosystem.

6. Acknowledgement

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